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ABSTRACT

Described is a five-week summer institute sponsored by the National Science Foundation for 35 teachers and administrators interested in implementing "AAAS Science - A Process Approach." Institute activities included those suggested in the AAAS "Guide for In-Service Training," with additional activities beginning the fifth week which required a synthesis of the individual process skills previously developed. Pre- and post-administrations of the "Science Process Measure for Teachers" indicated marked improvement in the nine areas of competency considered. A teacher-pupil verbal interaction analysis was performed before and after the institute in 18 classrooms with the results that the average teacher talking time went from 52.7 to 50.7 percent, student talking time from 29.4 to 19.5 percent, and silent activity time from 17.9 to 29.8 percent. An experiment conducted after the summer institute showed that 42 students in an experimental group using "AAAS Science - A Process Approach" scored significantly higher on 3 of 4 competency tasks than did 38 control group students using other materials. [Not available in hardcopy due to marginal legibility of original document.] (PR)

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FINAL REPORT ON THE NSF-CCSS GRANT GW-4164 CONDUCTED AT KANSAS STATE TEACHERS COLLEGE IN 1969-70

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One of the major challenges facing researchers in science education is to establish the credibility of our research with science teachers who might be expected to reap benefits from our efforts. It is sometimes difficult for teachers to understand or appreciate the potential of educational research for improving teacher effectiveness in the classroom. The NSF Cooperative College-School Science Program provides an excellent opportunity to involve teachers in research techniques and interpretation of data relevant to teaching.

The purpose of this paper then is to describe a NSF sponsored five week summer institute for 35 teachers and administrators interested in implementing AAAS Science-A Process Approach. Particular attention will be focused on the involvement of teachers in the evaluative aspects of the summer program and the subsequent academic year implementation.

Thirty elementary school teachers and five administrators were selected as institute participants from 13 rural school districts comprising the Flint Hills Educational Research and Development Association in south central Kansas. In April and May of 1969, the Flanders System of interaction analysis was used in 18 of the 30 classrooms to provide a composite matrix of classroom verbal interaction existing prior to the summer institute program. It was anticipated that classroom observations conducted the following

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year would indicate areas of change perhaps attributable to a combination of summer institute work and use of the new science materials. A comparison of this phase of the study will be discussed later in the paper.

The 1969 five week summer institute was held in the Science Building on the campus of Kansas State Teachers College and in the nearby Butcher Elementary campus school. Dr. Ed Kurtz was the co-director of the project and Mr. Herb Simmons was the coordinator of the micro-teaching phase of the program. Mrs. Ramona Anshutz was the research assistant during the academic year phase.

The format of the institute included the activities suggested in the AAAS Guide for In-service Training. In addition, a series of 11 experimental stations were set up the fifth week to encourage the participants to work on AAAS exercises which required a synthesis of the individual process skills which had been previously developed.

The participants also observed and worked with four afternoon classes of first and second grade students in Butcher Elementary School. Mr. Herb Simmons taught AAAS science exercises the first week and the participants observed through sound booths equipped with one way glass. During the next three weeks, teams of two teachers worked with groups of three and four students. In the final week each participant worked with one child. Selected activities from 24 AAAS exercises in Parts A, B, and C were taught in the four classes during the five week period.

The participants received personal copies of the AAAS Commentary for Teachers; response sheets for AAAS Guide for In-service Instruction;

and either Part B or Part C teacher texts for the AAAS Science-A Process Approach. Individual copies of a book by Amidon and Flanders, The Role of the Teacher in the Classroom A Manual for Understanding and Improving Teacher Classroom Behavior were also provided.

Science Process Measure for Teachers

The effectiveness of the summer institute was reflected in part by the pre-to post-measure gain in competency based on the Science Process Measure for Teachers, forms A and B. The pre-measure was administered on the second day of the institute and served as a means both of obtaining data and of informing the teachers as to the nature of the process skills which would be investigated in the program. The post-measure was administered at the end of the institute.

The analysis of the scores on the pre-and post-measures of the teachers provided the following statistics:

	Pre-Measure	Post-Measure	t-Test
Score Possible	25	25	
Subjects	35	35	
Mean	11.40	20.86	11.3[a]
Standard Deviation	4.67	2.15	
Range	3-20	15-24	

[a]Significant beyond the .001 level

The accompanying graph indicates the relative gain in competence in nine areas stressed in the Science Process Measure for Teachers. The post-measure results indicated that on five of the nine sections of the test the mean score was above the 90th percentile. Only two mean sub scores, Classifying and Use of Behavioral Objectives, were below the 80th percentile.

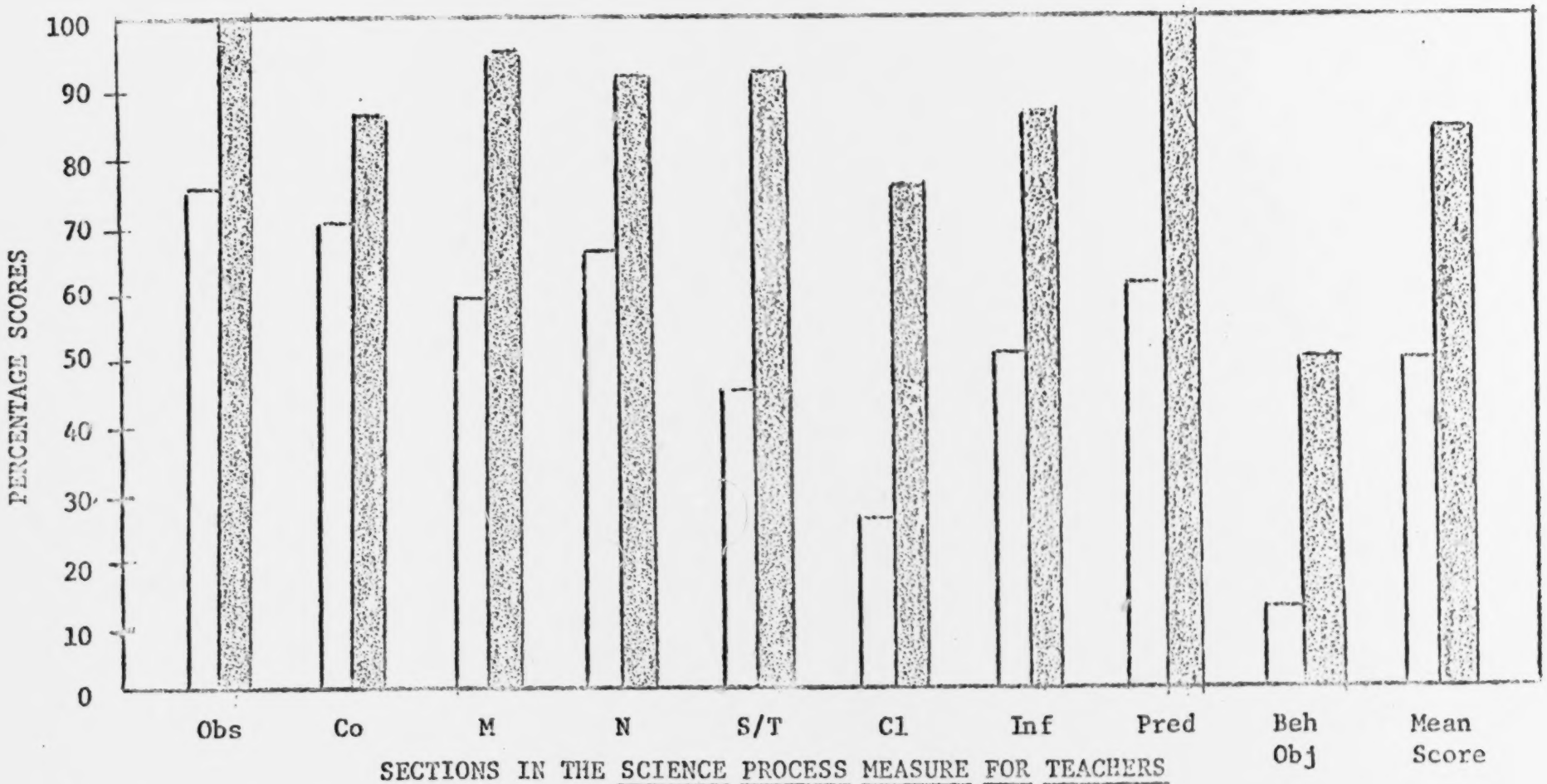
Set of Competency Tasks

In anticipation of the need to provide the participants with pertinent and understandable data as to the process skills possessed by first and second grade students, two testing instruments were developed by the project staff. The Set of Competency Tasks, Parts A and B consisted of 112 tasks selected from existing competency measures associated with 34 exercises in Parts A and B of Science-A Process Approach. A second test, The Set of Competency Tasks, Parts B and C, consisted of 105 competency tasks selected from 24 exercises in Parts B and C of Science-A Process Approach.

The participants viewed a video taped testing sequence and discussed the procedures and ground rules for administering the tests. In teams of two, the participants next went through one of the tests and familiarized themselves with the questions and supplies. Since each instrument required approximately one and a half hours to administer, each instrument was divided into two parts. Each team of testers spent a full day administering one of the parts of the instruments to four to six students in their respective school districts.

The combined test results were analyzed by the participants in terms of where one might begin teaching a particular process, such as measuring. In addition, each team of teachers, obtained information concerning a small sample of students that they would be instructing in the 1969-70 school year. The results of this study are presented in Tables I and II. The mean responses to individual tasks are combined under eight process headings.

COMPARISON OF MEAN SCORES ON THE PRE- AND POST-MEASURES OF 35 TEACHERS



SECTIONS IN THE SCIENCE PROCESS MEASURE FOR TEACHERS

Pre-test scores

Post-test scores

Obs - Observing
Co - Communicating
M - Measuring (metric)
N - Using Numbers
S/T - Space/Time Relationships
Cl - Classifying
Inf - Inferring
Pred - Predicting
Beh Obj - Behavioral Objectives

The project staff conducted a testing program using the same instruments as a part of a pre-and post-test design. This data is also included in Tables I and II.

The data on the Set of Competency Tasks, Parts A and B indicated that when the tests were administered by teachers that the mean student scores were higher on five of the six sub-tests in comparison with the student tested by the staff.

If one could assume that the two student population samples were similar in ability it would appear that the teachers might have tended to read too much into the students' responses. This possibility was discussed with the institute participants since they were expected to gather competency measure data on individual exercises during the academic year. The data from the Set of Competency Tasks, Part B and C neither supported nor refuted the possibility of observer bias in the administering of the test. No detailed statistical analysis was attempted since the contrasting data were collected for two different purposes under different conditions.

Interaction Analysis

The Flanders System of interaction analysis was used to gather data on the teacher-pupil verbal interaction in 18 classrooms prior to the summer institute. Each of the 18 teachers was observed while teaching an independently planned science lesson. The resulting composite matrix, composed of 3,457 tallies, indicated that on the average 52.7 per cent of the total class time involved teacher talk, student talk accounted for 29.4 per cent of the total time and silent activities or confusion accounted for 17.9 per cent of the time.

TABLE I
MEAN SUB-SCORES ON SET OF COMPETENCY TASKS PARTS A AND B
FOR TWO GROUPS OF FIRST GRADERS

	MEAN ACCEPTABLE RESPONSES		TOTAL POSSIBLE SCORE
	Tested by Participant (N=47+28)	Tested by Staff (N=30+25)	
Observing	9.7	5.7	16
Measuring	10.8	6.7	21
Classifying	5.3	3.9	8
Using Numbers	8.5	8.9	19
Communicating	6.4	3.5	21
Space/Time	11.3	11.1	27

TABLE II
MEAN SUB-SCORES ON SET OF COMPETENCY TASKS, PART B AND C
FOR TWO GROUPS OF SECOND GRADERS

	MEAN ACCEPTABLE RESPONSES		TOTAL POSSIBLE SCORE
	Tested by Participant (N=30+21)	Tested by Staff (N=26+27)	
Observing	5.4	6.3	8
Classifying	4.2	4.8	10
Measuring	7.3	7.5	18
Communicating	5.4	4.0	19
Using Numbers	9.4	9.6	18
Space/Time	3.7	2.1	7
Predicting	3.8	2.9	12
Inferring	7.6	4.9	13

The results of the pre-institute interaction observations were used along with audio training tapes to acquaint the teachers with the Flanders System of interaction analysis. The purpose of this ten hours of training was to provide the participants with one system for quantifying verbal interaction during the observation phase of the institute and at the same time to suggest a way for each individual to look at his own teaching style when he returned to the classroom.

During the academic year phase, video tapes were made of nine of the participants teaching AAAS exercises in their own classrooms. These video tapes were analyzed using the Flanders System of interaction analysis. The results are given in Table III along with data from the pre-institute observations. In comparing the post-institute interaction data with the pre-institute observational data, it appeared that the category of silence had increased from 17.93 per cent to 29.80 per cent reflecting more student involvement. Teacher talk was reduced only slightly and student talk had been reduced from 29.37 per cent to 19.54 per cent. The various I/D Ratios have only changed slightly.

TABLE III
PRE AND POST-MEASURES OF INTERACTION ANALYSIS FACTORS

	Pre-Measure Spring of 1969 (N=18 teachers)	Post-Measure Fall of 1969 (N=9 teachers)
I/D Ratio	0.510	0.599
Revised I/D Ratio	0.501	0.465
Extended Indirect	1.28	1.25
Extended Direct	3.67	4.64
Per Cent Teacher Talk	52.70	50.66
Per Cent Student Talk	29.37	19.54
Per Cent Column 1	0.20	0.55
Per Cent Column 2	5.73	6.24
Per Cent Column 3	4.89	5.61
Per Cent Column 4	16.05	17.95
Per Cent Column 5	15.07	6.03
Per Cent Column 6	8.94	12.82
Per Cent Column 7	1.82	1.46
Per Cent Column 8	17.62	13.58
Per Cent Column 9	11.74	5.96
Per Cent Column 10	17.93	29.80

Amount of Teacher Participation during the Academic Year

Thirty-five participants completed the summer institute phase of the project. In terms of actually teaching the AAAS exercises during the following school year, the number of teachers was reduced to twenty-three. The group of twelve participants who did not teach included one superintendent, four school principals, one participant who did not return to teaching, three teachers assigned to grade levels other than Kindergarten through grade three, two teachers not using the materials and one participant who joined the project staff as an assistant. The five administrators were included in the summer institute to provide them with the training necessary for them to make future decisions regarding the implementation of the program throughout their schools.

AAAS Exercises Taught

A tally was kept of the number of exercises taught in Parts A, B, and C of Science-A Process Approach. Six different patterns for combining exercises from the various Parts were evident. These patterns seemed to reflect both the diversity of teaching assignments within the 13 rural unified school districts and the recognition of a need to provide prior experiences before preceding with more advanced exercises. The following tabulation represents the number of exercises taught by each of twenty-three teachers.

AAAS PARTS	A	AB	B	BC	C	ABC
	9	20	1	22	15	13
	13	31	1	43		27
	22		1			30
			3			43
			4			
			5			
			6			
			7			
			10			
			14			
			18			

By combining the teachers into two groups, it would appear that the 15 teachers using only one part of the series had a median of 7 exercises as compared with a median of 28.5 exercises taught by the eight teachers using two or more Parts. The overall mean number of exercises taught by the 23 teachers was 15. The median number of lessons taught by the group of 23 teachers was 13 exercises.

Availability of AAAS Kit Materials

At the beginning of the academic year phase of this project,

one complete Part A Kit, thirteen Part B Kits, and 8 Part C Kits were distributed among the participants. Five additional Part A Kits were subsequently purchased by individual school districts on the recommendation of the local teachers.

A central supply of materials was maintained at the project headquarters for a semester but distance and lack of demand resulted in these kits being placed in the schools of the participants. A second central supply system for science materials based on the OMSI specifications was set up in the middle of the year in one of the cooperating schools.

Student Achievement

In the fall of 1969, 108 students were pre-tested using one of four forms of an individually administered Set of Competency Tasks. In April and May of 1970, 97 of these students were given the post-test. The students in this sample population were divided into control and experimental groups based on whether they had received instruction in AAAS Science-A Process Approach. The four tests included: Part B-First Half, Part B-Second Half, Part C-First Half, and Part C-Second Half.

The Mann-Whitney U test was used to determine whether any significant differences existed between the control groups and the experimental groups at the beginning of the year and after the experimental group had received instruction in the AAAS materials.

Set of Competency Tasks, Part B, First Half

This testing instrument consisted of 45 tasks involving the

processes of observing, measuring, and classifying. These tasks were selected from existing competency measures associated with selected exercises from Parts A and B of the program. This test was administered as a pre-and post-test to 10 students in the control group and 13 students in the experimental group. These students represented a random sample of students selected from four control group classrooms and five experimental group classrooms. A Mann-Whitney U value of 41 was obtained from a comparison of pre-test scores. This analysis indicated that no significant difference existed at the .10 level, using a two-tailed test, between the scores of the experimental and control groups on the Part B First Half test given prior to instruction.

After the experimental group had received instruction in the AAAS material a post-test was given. A Mann-Whitney U value of 12 indicated that a significant difference existed, at the .02 level using a two tailed test, between the control and experimental groups. The difference reflected greater achievement on the part of the experimental group.

Set of Competency Tasks, Part B Second Half

This testing instrument consisted of 66 tasks representing the processes of using numbers, communicating and space time relations as described in selected exercises from Parts A and B of the AAAS material. There were 8 control students representing 4 different classrooms and 10 experimental students from 4 classrooms.

A comparison of the achievement scores of the two groups on the pre-test provided a Mann-Whitney U of 34 which meant that there

was no significant differences between the scores of the two groups at the .10 level for two tailed tests.

A Mann-Whitney U value of 33 was obtained from the analysis of the post-test scores. This indicated that after instruction in AAAS there was still no significant difference between the experimental and control groups at the .10 level.

Set of Competency Tasks, Part C First Half

This testing instrument consisted of 36 tasks selected from 2 observing exercises, 3 classifying exercises, and 5 measuring exercises in Parts B and C of the AAAS materials. Ten control students from four classrooms were tested in a pre-and post-test design.

A Mann-Whitney U value of 32 indicated that there was no significant difference at the .10 level, using a two-tailed test, between the experimental and control groups at the beginning of the year. The results of the post-test comparison provided a U value of 12 which was significant at the .02 level using a two-tailed test. Thus a significant difference was observed which indicated that the experimental group outperformed the control group on the post-test.

Set of Competency Tasks, Part C Second Half

This testing instrument consisted of 61 competency tasks selected from 3 communicating exercises, 4 using numbers exercises, 2 space/time exercises, 2 predicting exercises, and 2 inferring exercises selected from parts B and C of the AAAS materials. Ten control and ten experimental students representing eight different classrooms were administered this set of competency tasks twice.

On the pre-test, a U value of 8 indicated that a significant difference at the .002 level existed between the control and experimental groups. That is the ten students chosen at random from the control classrooms scored much lower on the pre-test than did the experimental group. On the pre-test measure a U value of 13 indicated that the experimental group scored significantly higher on the post-test measure. However, the difference was significant at only the .02 level. One possible interpretation would be that the experimental group's greater achievement on the post-test was due to their initial advantage as reflected by their pre-test scores. A third Mann-Whitney U test was used to determine if there was a significant difference between the two groups based on gain in achievement from pre- to post-test. A U value of 35 indicated that no significant difference existed at the .10 level using a two-tailed test. These results, however, appear to be related to a test ceiling effect. That is the experimental group scored appreciably higher on the pre-test and thus had less margin in which to improve. The following mean scores for both groups tends to support the test ceiling effect. The control group pre-test mean was 17.6 with a post-test mean of 26.2. The experimental group had a pre-test mean of 29.7 and a post-test mean of 42.3. Using these figures it would appear that the control group post-test mean was still less than the pre-test mean of the experimental group.

Summary of Testing

A total of 38 students in the control group and 42 students in the experimental group were used in the analysis of achievement.

Since 97 students were post-tested it is obvious that 17 students were not included in the final analysis. These students were from classes of six experimental teachers who had taught only five or less AAAS exercises and thus could not be described as having taught the AAAS materials to an appreciable extent.

The analysis of initial differences between the four pairs of control and experimental groups indicated that only in one of the four pairs of groups did a significant difference exist prior to instruction. In this one case the experimental group outperformed the control.

The analysis of differences on the post-test scores indicated that in three of the four cases the experimental groups scored significantly higher than did the corresponding control group. The use of the Part B, Second Half Set of Competency tasks did not provide any support for the contention that the experimental group had outperformed the control group. The lack of gain in achievement might be attributable to the decision of some of the experimental group teachers to not teach certain exercises used in the test.

Competency Measures

The participants were encouraged to periodically administer the Competency Measures associated with each AAAS exercise to a random sample of two or three students after completing instruction on a particular exercise. The following three tables represent the competency measures given by the participants. The number of students tested and the percent of students who acquired 90 per cent of the tasks are given for each exercise. The computation of the percentage

figure is as follows:

$$\frac{\text{sum of correct responses for all students tested}}{\text{(perfect individual score) (students tested) (.90)}} \times 100$$

The standard level of expectation with respect to the acquisition of desired behavior was that 90 per cent of the children tested would acquire 90 per cent of the specified behavior. This 90/90 level was recommended in the AAAS publication entitled An Evaluation Model and Its Application. In part A of the following exercises, 10 of the 15 exercises met this standard. In Part B, 12 of the 14 exercises met this standard. In Part C, 14 of the 21 exercises met the 90/90 level.

Post Academic Year Workshop

In the course of the academic year phase of this project, a number of non-institute teachers expressed an interest in the AAAS Science-A Process Approach.

The project staff arranged a non-credit three day workshop for these Flint Hills Association teachers which was held on June 4-6, 1970 at Kansas State Teachers College. Thirty-three teachers attended the workshop which was conducted by Dr. Edwin Kurtz, assisted by Dr. Bernadette Menhusen. The first day's activity included activities based on the processes of observing, classifying, inferring and predicting. On the second day, the participants worked with behavioral objectives, and action words. In addition the assessment of student performance was discussed. In the afternoon, the participants took the Process Measure for Teachers and then used the test for self study.

Part A Competency Measures

Exercises	Percent of students who acquired 90% of the tasks	Number of students tested
d	100	11
g	99	11
h	99	11
k	100	22
l	100	3
m	83	3
n	55	3
o	100	3
p	100	3
q	68	14
r	100	3
s	100	3
t	100	14
u	67	3
v	85	3
	Part B Competency Measures	
a	100	34
b	99	40
c	88	11
d	95	30
e	99	19
f	100	20
g	91	16
h	99	9
i	78	20
k	100	10
l	93	16
q	100	20
s	100	11
t	100	11
	Part C Competency Measures	
a	87	14
b	83	11
c	79	8
d	90	17
e	91	9
f	98	15
g	76	20
h	100	7
i	75	9
j	89	16
k	100	9
l	75	9
m	89	8
n	100	4
o	99	9
p	94	5
q	100	2
r	100	5
s	100	2
t	100	2
u	61	3

On the final day, the participants and experienced project teachers worked together in small groups to discuss problems encountered in teaching the AAAS exercises.

A majority of the workshop participants elected the option of continuing to study the AAAS curriculum by means of an individual conference course which was conducted for the remainder of the summer school session. Those teachers choosing to continue generally selected a project which involved use of the competency tasks with youngsters.

Academic Year In-service Sessions

Twelve in-service sessions were conducted during the 1969-70 academic year. Two of the twelve sessions were held off campus in cooperating schools. The remainder were held at Kansas State Teachers College and at the annual meeting of the Kansas Association of Teachers of Science held at a camp site near Junction City, Kansas.

Generally 20-22 teachers were present at the in-service sessions. At the conclusion of these sessions, brief assessment forms were filled out anonymously by the participants and used in assessing the session and planning subsequent sessions. Some of the activities that were well received included: discussion in small groups, observation and discussion of video tapes of participants teaching, presentation and experience with the use of a central supply system, and discussion by Dr. Kurtz regarding AAAS programs underway in other parts of the country. On April 22, 1970 the institute participants toured a large dairy operation near Madison, Kansas in conjunction with the observation of Environmental Teach-In.

The staff members were also primarily responsible for an administrators workshop on science held at Kansas State Teachers College on May 7, 1970. The all day workshop featured demonstrations of the new elementary and secondary science curricula. The program was attended by over 100 school administrators from throughout Kansas.

The final activity of the institute was a three day AAAS workshop for teachers interested in learning about the program. A group of the NSF participants served as resource and discussion leaders on the final day of the workshop.

Limitations and Recommendations

A substantial portion of the summer institute was directed toward teacher involvement with students in the campus school. It would seem that instead of initially projecting the participants into teaching situations with observers present, it would have been better to let the teachers initially administer competency measures after several complete exercises had been taught by a staff member. This would be followed by one to one teaching and eventually one teacher working with a small group.

The potential of the interaction analysis training would have been enhanced if all teachers could have been video taped while teaching, then each teacher could have constructed his own matrix for interpretation. Ideally the teacher should be video taped several times to provide him with an opportunity to attempt to alter his teaching and receive feedback.

The opportunity to work at eleven experimental stations was seemingly a successful culminating activity during the last week of

the institute. It would be interesting to lengthen the period in which the teachers could investigate a particular problem and determine whether the teachers demonstrated interest in repeating an experiment or in altering their problem solving approach.

In summary the participants in the summer program actively engaged in improving their own intellectual skills in preparation for working with students. The concept of behavioral objectives as a basis for instruction and assessment of the progress of students was hopefully reinforced by the micro-teaching activities and the gathering of competency task data from students.

The half day in-service meetings provided the teachers an opportunity to compare notes, discuss problems, and receive encouragement from one another. The staff has attempted to provide experiences which would provoke discussion and encourage change on the part of the teachers. The follow-up workshop held in June was an excellent way to provide information and experiences to enable the workshop teachers to begin teaching the AAAS exercises the following year, assisted by the experienced AAAS teachers.

The testing program could be improved by determining in advance which exercises would definitely be taught during the school year so that a more accurate measurement could be obtained of student achievement. The continued use of individually administered competency tasks is recommended even though it is a time consuming operation.